ACCELERATED 3D T2* MAPPING WITH MAXIMUM LIKELIHOOD ESTIMATION(MLE) AND PARALLEL IMAGING(PI)

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Introduction

The quantification of tissue parameters from MRI datasets is emerging as a powerful tool for tissue characterization. The utilization of the technique in clinical scenarios is limited due to lengthy acquisition time. A common approach to reduce the scan time is to limit the number of weighted images from which the parameters are estimated. However, this approach precludes the use of multi-exponential fitting methods, limits the accuracy of fits, and restrict the dynamic range of estimated tissue parameters. In addition, exponential fitting in the magnitude image poses the bias in the estimation due to incorrect noise model. While previous work has addressed this issue by correcting for the noise model[1] or by performing fitting in complex domain[2], no previous work has incorporated the multichannel information. In addition, no work has been done to explore the utility of complex data in the undersampled cases. Our MLE-SENSE approach addresses these issue in an undersampled case and demonstrated that incorporating the complex data can result in better denoising and reduce error.

Methods

In vivo data was acquired on a 1.5T MRI scanner (GE Signa, Milwaukee, WI, USA). The proposed MLE[3] approach was tested on a 3D T2* mapping sequence in a phantom and a healthy volunteer. The data set was acquired with an 8 channel head coil using a 3D-enhanced fast gradient-recalled echo sequence with the following parameters (8 echoes, TR=67 ms, FOV= 156mm, 160 slices, readout Bandwidth=13.56 KHz, ip angle 15, 1.3 mm slice thickness). The acquisition time for a fully sampled scan was 21 minutes. Accelerated datasets were acquired for different acceleration factor(R=2,3,4,5,6). For the undersampling poisson disk undersampling mask with a 32x32 fully sampled center was used. All algorithms were implemented in Matlab (The Mathworks, Natick, MA, USA). To compare the accuracy of our proposed approach, T2 * maps were generated using both the magnitude only and the complex data. The coil sensitivity maps were self-calibrated by averaging undersampled k-space data over time and computed using the method described in [12]. The undersampled data was reconstructed using SENSE and T2* maps were obtained using MLE.

Results

T2* maps obtained from the fully sampled data and the maps from undersampled data for the brain figure 1 (a&b) with the magnitude and the complex data. The RMSE with respect to the fully sampled map is given below each map. T2* maps showed the same trend with increased RMSE with increasing acceleration factor. The results show that for the brain the complex methods tends to work well with lesser error as compared to magnitude.

Conclusion

The proposed MLE-SENSE reconstruction allows reconstruction of T2* maps using the complex data up to the acceleration factor of 6. The method allows significant reduction of the scan acquisition time without compromising the quality of the parameter maps.

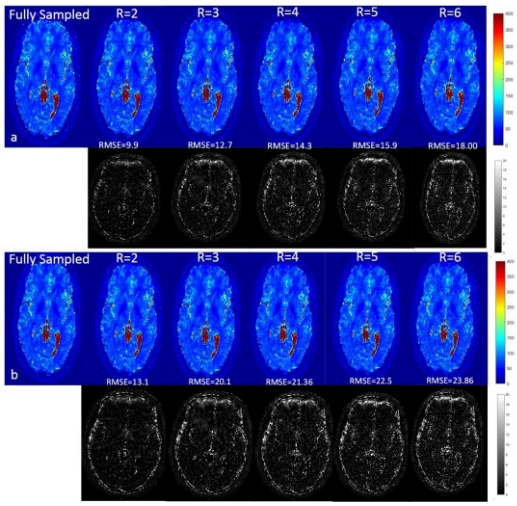

Figure 2: (a) T2 maps of the fully sampled dataset of brain reconstructed with (a) Complex (b) Magnitude for acceleration factor of 2, 3,4,5,6 are shown in the top row. The corresponding difference of the T2* maps between fully sampled and the undersampled data are shown in the bottom row with the RMSE. The color bar shows the T2* values in ms.*

References

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